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SMITHSONIAN INSTITUTION.

DIRECTIONS

FOR

METEOROLOGICAL OBSERVATIONS,

INTENDED FOR THE

FIRST CLASS OF OBSERVERS.

WASHINGTON CITY:
1850.

John T. Towers, Printer.

PREFACE.

The following directions are especially intended for observers in the United States, who are willing to take part in a system of Meteorological Observations, to be extended, as far as possible, over the whole country. They form an Appendix to the Report on Meteorological Instruments and Observations, prepared by Professor Guyot for the Smithsonian Institution. It is intended in these directions to give in full detail all the explanations and precautions necessary for making complete sets of observations of the degree of accuracy absolutely required by the present state of science.

The Smithsonian Institution intends to publish, as far as its means will allow, all the valuable materials relative to the Meteorology of this country, not otherwise given to the world; but it will be readily understood that only such journals as are kept with the requisite degree of care, and which clearly present the character of trustworthiness can claim the privilege of being given in full to the public.

JOSEPH HENRY,
Secretary of Smithsonian Institution.

Smithsonian Institution,
Jan. 5, 1850.

[The Report above mentioned will be printed in the course of a few weeks, and a copy sent to each observer.]

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DIRECTIONS

FOR

METEOROLOGICAL OBSERVATIONS,

ADOPTED BY THE SMITHSONIAN INSTITUTION.

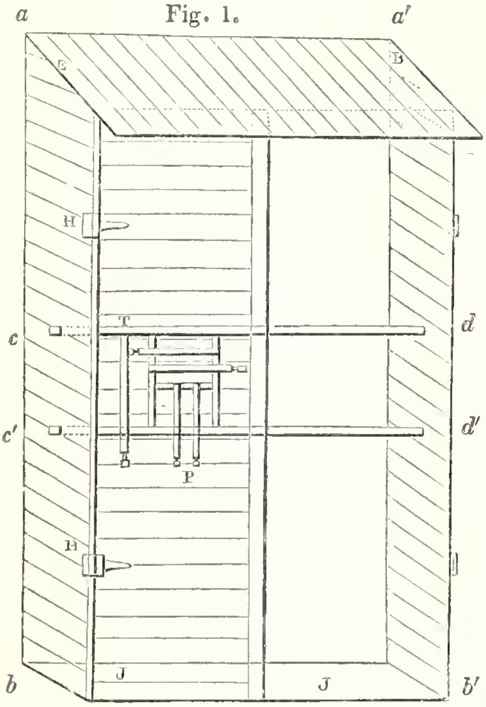
PLACING AND MANAGEMENT OF THE INSTRUMENTS.

THERMOMETER.

Placing.—Place the Thermometer in the open air, and in an open space, out of the vicinity of high buildings, or of any obstacle that impedes the free circulation of the air. It should be so situated as to face the north, to be always in the shade, and be at least from nine to twelve inches from the walls of the building, and from every other neighboring object. The height from the ground should be from ten to fifteen feet, and as far as possible, it should be the same at all the stations. The instrument should be protected against its own radiation to the sky, and against the light reflected by neighboring objects, such as buildings, the ground itself, and sheltered from the rain, snow, and hail. The following arrangement will fulfil these requirements, (Fig. 1.)

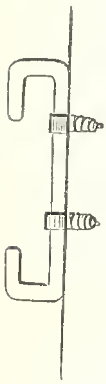
Select a window situated in the first story, fronting the north, in a room not heated or inhabited; remove the lattice blinds, if there be any, and along the exterior jambs of the window place perpendicularly two pieces of board, (*a b*—*a′ b′*), projecting to a distance of from twenty to twenty-four inches from the panes. At half this distance, ten or twelve inches from the panes, and at the height of the eye of the observer, when in the chamber, pass from one piece of board to the other two small wooden transverse bars, (c d, c′ d′) each an inch broad, for the purpose of supporting the instruments. Upon the outer edge of the boards fasten in the usual way, (H H) the latticed blinds which were removed from the jambs, or two others provided for the purpose. That blind, behind which the instruments are to be placed, is to serve as a screen, and must be fastened, almost entirely closed, so as to make a little more opening; the other will remain entirely open to allow a free access of air and light, and is not to be closed except in great storms. The whole must be covered with a small inclined roof of board, (B E) placed at least fifteen or twenty inches above the instrument. The lower part (J J) or the basis, may remain open.

Fig. 1.



View from the outside.

Fig. 2.



The Thermometer must be placed exactly perpendicular, the middle of the scale being at the height of the eye against the two small wooden bars, so that the top of the scale being fixed by a screw to the upper bar, the bulb may pass at least two or three inches beyond the lower bar. The instrument is attached to the last by a little metallic clasp. (Fig. 2.) It will thus be placed ten or twelve inches from the panes, from the screen, and the other parts of the window.

Reading.—To read the Thermometer, the eye must be placed exactly at the same height as the column of mercury. Unless this precaution is taken, there is a liability to errors, the greater in proportion to the thickness of the glass of the stem, and the shortness of the degrees. The reading should be made at all times, and especially in the winter, through the panes, and without opening the window; otherwise the temperature of the chamber will inevitably influence the Thermometer in the open air. The degrees must be read, and the fractions carefully estimated in tenths of degrees. After having rapidly taken the observation, another should be made to verify it. If there are several other instruments to observe, and the Thermometer is to be read first, the first reading may be made some minutes before the hour; the second after the reading of the psychrometer, and if there is a difference, the mean number is to be entered in the journal. When, notwithstanding the shelter, the bulb of the Thermometer is moistened by rain or fog, or covered with ice or snow, it is necessary to wipe it rapidly, and not to record the degree until the instrument has been allowed to acquire the true temperature of the air.

Verification.—Verify the zero point, at the beginning and end of winter. For this purpose, fill a small tub with snow, immerse the bulb of the Thermometer in the middle of it, so as to be surrounded in every direction by a layer of several inches of snow, slightly pressed around the instrument. The stem must be placed exactly perpendicular, and covered with snow as far up as the freezing point on the scale. Let it stand so for half an hour or more, and then read it, taking great care to place the eye on the same height as the summit of the mercurial column. If the top of the column does not coincide with the feezing point of the scale the exact amount of the difference must be ascertained, and the correction immediately applied. At the same time enter in the journal, under its appropriate head, the day on which it has been made out, its quantity, and the moment at which the application of it was commenced. If you have a Thermometer with an adjustment, such as is described in the accompanying Report,* uncover the screw by which the tube is suspended at the top of the scale, while the instrument is still in the snow, and turn it by means of a screw-driver, until the top of the column corresponds exactly to the zero of the scale, then replace the plate which covers the head of the screw.

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* Report on Meteorological Instruments &c. to the Smithsonian Institution.

SELF-REGISTERING THERMOMETERS.

Placing.—These two Thermometers, indicating the maxima and minima, are to be placed beside the common Thermometer in a horizontal position, with the bulbs opposite and free, on two small perpendicular supports uniting the two bars, as shown in (Fig. 1.)

Reading.—For the reading, place the eye in such a manner that the visual ray may be perpendicular to the extremity of the index; enter the indications with the fractions of degrees, if there are any; and after having verified them again, bring back, by means of the magnet, the indexes of the two Thermometers to the summit of their respective columns.

Verification.—Compare the indications of the two Thermometers frequently, and especially the spirit Thermometer, with those of the common Thermometer; verify the zeros at least *twice a year*, and if there is a difference, adjust the zero anew, if the instrument permits, to eliminate the correction, as has been stated above for the simple Thermometer; or take this correction into account in the register.

PSYCHROMETER.

Placing.—The Psychrometer, or wet-bulb Thermometer, must be situated under the same conditions as the Thermometer. It should be placed on the same wooden bars, several inches off, and outside of the Thermometer, (See Fig. 1.)

The bulbs should also be entirely free, and at a distance from the bars.

In case of violent winds, the instrument may be sheltered by the moveable blind, which may also serve as a fan to promote evaporation when the air is too still.

The cloth which surrounds the bulb ought to be of medium fineness, not too coarse; it should form a covering of equal thickness on all sides, and should not be drawn too closely upon the glass. Linen is preferable to cotton, which retains the dust. The covering should be changed every two or three months, and the bulb cleaned.

Observation.—For the observation, take first a small vessel full of water, which should be left on the window, that the water may be at the temperature of the air; bring it near to the bulb, and immerse the bulb several times into the water. All the space between the bulb and the bottom of the scale must be wet, and care must be taken that the wrapping is thoroughly moistened, without however a too large drop remaining suspended at the bulb. The water used must be pure; the best is rain water filtered, because it does not hold any salt in solution, which might incrust the cloth after evaporation.

After this operation, shut the window, and leave the Psychrometer for a moment.

While the wet bulb is slowly acquiring the temperature of evaporation, the observer is occupied with other observations, watching the Psychrometer to make sure of the moment when it has become stationary. In summer, from four to ten minutes are needed for this, according to the size of the bulb; but in winter, when the water freezes on the bulb, it must be moistened from fifteen to thirty minutes before the observation, which should not be made until the ice around the bulb is quite formed and dry. The best way is to keep round the bulb a layer of ice, constant and uniform, which should be neither too thick nor too thin; then the observation may take place immediately. When the temperature is in the neighborhood of the freezing point, the observation of the Psychrometer requires very peculiar care; the reason of which we have elsewhere explained.* During a fog the wet-bulb Thermometer may be somewhat higher than the dry bulb; then the air is over-saturated, and contains besides the vapor at its maximum of tension, water suspended in a disseminated liquid state.

If the air is very still, it is well to increase the evaporation by setting the air in motion by a fan. If the wind is too strong, the instrument should be protected by the moveable blind. The reading must be made rapidly, and, as much as possible, at a distance, and without opening the window; for the proximity of the observer, either by the heat radiating from his body, or by his breath, as well as the temperature and the hygrometrical state of the air issuing from the chamber, which is always different from that of the external air, especially in winter, would infallibly act upon the instruments, and would falsify the observation.

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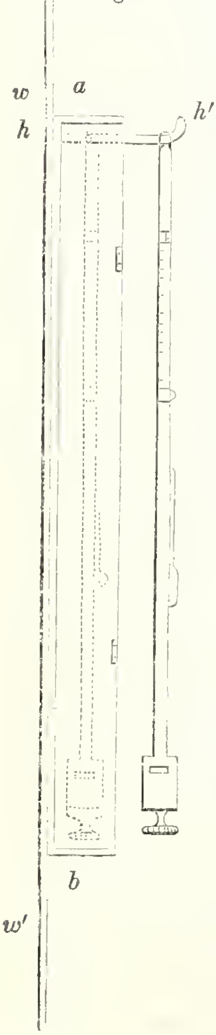
* See Report on Meteorological Instruments.

Verification.—The two Thermometers must be carefully compared from time to time, and if a difference is found, the instruments must be adjusted, or it must be taken into the account, and the observations corrected when entered in the journal.

BAROMETER.

Placing.—The Barometer should be placed in a room, of a temperature as uniform as possible, not heated nor too much exposed to the sun. The instrument must be suspended at the height of the eye, near a window, in such a manner as to be lighted perfectly, without exposure either to the direct rays of the sun, or to the currents of the air, which always take place at the joinings of the windows. When the Barometer has to be fixed to the wall, as is the case with all the common stationary and wheel Barometers, care must be taken to secure the tube in a position perfectly vertical, regulating it by the plumb line, first in front, then at the sides, at least in two vertical planes cutting each other at right angles. When the instrument is so constructed as to take its equilibrium itself, as the Fortin Barometers and those of J. Green, recently made under the direction of the Smithsonian Institution, it is enough to hang it on a strong hook. These conditions being fulfilled, the rest of the arrangement may be varied according to the nature of the localities. For the Fortin and Green Barometers, the following seems to be the most convenient, and may be almost every where adopted. (See Fig. 4.)

Fig. 3.



A small oblong box (*a b*) some inches longer than the Barometer, and a little broader than its cistern, is firmly set against the wall, (*w w′*,) near the window, in such a manner as to open in a direction parallel to the panes; at the summit (*a*) it has a strong hook (*h h'*), which extends beyond the box about two or three inches, and on which the Barometer is suspended. The instrument remains generally in the box, which is closed by a moveable cover, and which protects it from external injuries, from dust, and from the direct radiation of the warm bodies, or the currents of air from the window, and diminishes the effect of the too sudden variations of temperature. When it is to be observed, the Barometer is taken by the upper end of the tube, the suspending ring is made to slide towards the end of the hook. The instrument is, then, in the full light of the window, in front of which the observer places himself; the summit of the mercurial column, as well as the surface of the mercury in the cistern, are completely lighted, and the reading becomes easy and certain. Moreover, the slight oscillating movement impressed on the instrument, by changing its place, breaks the adherence of the mercury to the glass, and thus prepares a good observation. After the reading, the Barometer is again slipped gently into the box, and this is closed.

Observation.—The different operations of the Barometer of constant level, should be made in the following order:

(*a.*) Before all, incline the instrument gently, so as to render the mercurial column very moveable; then, after having restored it to rest, strike several slight blows upon the casing, in such a manner as to impress on the mercury gentle vibrations. The adherence of the mercury to the glass, will thus be destroyed, and the column will take its true equilibrium.

b. Note the degree and the tenths of degrees of the thermometer attached to the instrument; for it will be seen that the heat of the observer's body soon makes it rise.

c. Bring, by means of the adjusting screw, (fig. 4,) the surface of the mercury to its constant level. In Green's first barometers, the metallic envelope of the cistern is pierced through (*o o'*) and allows the surface of the mercury contained in the glass cistern to be seen. The plain which passes through the upper edge (*e e'*) of this opening, is the true level, or the *zero* of the scale, to which the surface of the mercury must be restored.

For this, take hold, with the left hand, of the lower edge of the cistern, (*l l′*) taking great care not to disturb its vertical position; apply the right hand to the adjusting screw, (*s*) and turning it gently, bring by degrees the level surface of the mercury to the upper edge (*e e′*) of the opening of the cistern, until there remains between the two only an almost imperceptible line of light, as in the fig. 5 (*e e′*.) Then, leave the instrument to itself to reëstablish its verticality, if it had been accidentally deranged, and placing the eye exactly at the height of the mercury, examine whether the contact is exact. For this operation, it is important to have a good light; the cistern ought to be placed higher than the lower edge of the window, so that the light may reach it directly. It is necessary also to take care not to confound the slight line of light which marks the opposite edge of the cistern, with the light reflected by the surface of the mercury against the inner walls; the former is always sharp and well defined, the latter vague and indefinite. When, before adjusting the level, the mercury is higher than the upper edge, it is necessary to begin by lowering it beneath the level, (see fig. 4,) so as to leave an interval of light, which is then gradually shut out, as has been described. When

Fig. 4.

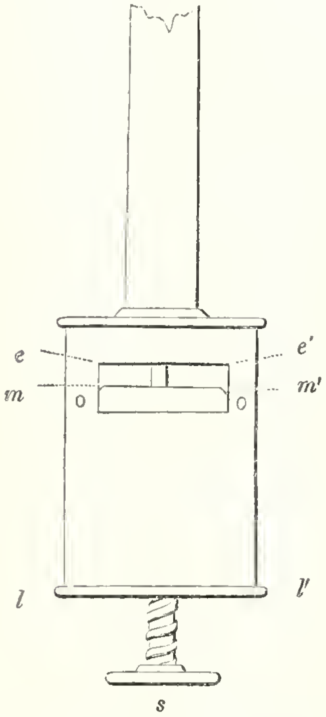
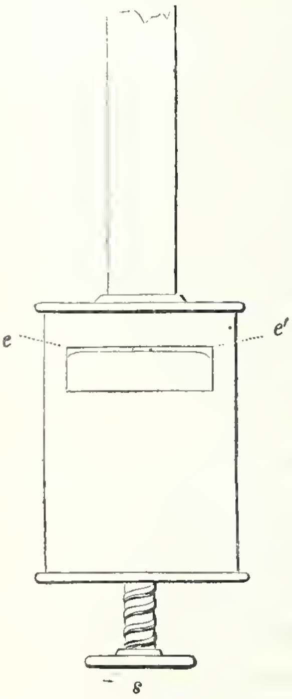


Fig. 5.



the observation is to be made in the night, place the lamp before, and not behind, the instrument, and somewhat higher than the eye; and if the wall itself is not light enough, place behind the cistern, or the top of the column, a piece of white paper, which reflects the light.

In the Barometers with an ivory point, as the Fortin, Newman, and Green barometers, the extremity of this point is the zero of the scale, which must be brought into exact contact with the surface of the mercury. We commonly judge that it takes place when we see the actual rounded summit of the point coincide exactly with its image reflected below by the mercury. This method may be very good when the surface of the mercury is perfectly pure and brilliant; but this is very rare; it is generally dimmed by a slight layer of oxide, which makes the coincidence of the point with its image uncertain. It is safer to judge of the contact in a different manner. From the moment when the point does more than touch the surface, it forms around itself, by capillary action, a small depression, which, breaking the direction of the reflected rays, becomes immediately very easy to discover. It is enough, then, to raise the mercury so as slightly to immerse the point, then to lower it gradually until the little depression disappears. If care is taken to make a good light fall on that portion of the mercury which is under the point, and to use the aid of a magnifier, the adjustment of the point thus made becomes not only easy, but very certain, and the errors to which we are liable are almost insensible, for they do not exceed two or three hundredths of a millimetre, or a thousandth of an inch.

d. The level being thus adjusted to the zero of the scale, we proceed to observe the height of the summit of the column. Take hold of the instrument with the left hand, above the attached Thermometer, without moving it from the vertical; strike several slight blows in the neighborhood of the top of the column; then, by means of the screw lower the slide which carries the vernier, until the plane passing through the two lower opposite edges of it is exactly tangent to the summit of the *meniscus*, that is, the convexity which terminates the column. We know that this is the case when, placing the eye exactly at the height of the summit of the column, we still see the summit of the column, without there being any trace of light between the summit and the edge of the ring. To convince ourselves that the Barometer has remained quite vertical during this operation, we leave it to itself, and, when it is at rest, we look again to see whether the ring has remained tangentical to the summit of the column. If it has not, the verticality had been disturbed; it must be adjusted anew. It is necessary, at the same time, to examine if the adjustment of the surface of the mercury in the cistern has remained the same. The attached thermometer will also be read anew, and if it indicates a temperature noticibly higher than at the commencement of the observation, a mean value between the two indications must be adopted. An exact observer can never dispense with these verifications.

e. Nothing more then remains than to read the instrument. In the English Barometers the inches and tenths of inches are read directly on the scale, the hundredths and thousandths on the vernier. In the French Barometers, with the metrical scale, the centimeters and millimetres are read on the scale, and the fractions of millimetres on the vernier. We begin by reading on the scale the number of inches and tenths of an inch, or of millimetres, there are as far up as the line which corresponds to the *lower* edge of the vernier, and which marks the summit of the column. In the Green Barometers this line marks at the same time the zero of the vernier. If this line does not coincide with one of the divisions of the scale, we read the fraction of the following division on the vernier.

The principle of the vernier is very simple. If we wish to obtain tenths, we divide into ten parts a space on the vernier comprising nine parts of the scale, (see fig. 5,) each division of the vernier is thus found shorter by a tenth than each division of the scale. Now if we start from the point where the zero of the vernier and its tenth division coincide exactly with the first and the ninth division of the scale, and if we cause the vernier to move gradually from the ninth to the tenth division of the scale, we shall see the first, the second, the third, and the other divisions of the vernier as far as the tenth, coincide successively with one of the divisions of the scale. Now, the divisions of the scale to which those of the vernier corresponds, being equal parts, it follows that the space in question has been successively divided into ten parts, or tenths, by these successive coincidences. If the scale bears millimetres, the vernier will give tenths of millimetres; if it has tenths of an inch, the vernier will give hundredths. By changing the proportions, it may be made to indicate by the vernier smaller fractions, as twentieths of millimetres, or five hundredths of an inch, &c.

To read the vernier, we must look out for the line that coincides with one of the divisions of the scale; the number of this division of the vernier, proceeding from zero, indicates the number of tenths of millimetres, or of hundredths of an inch, which must be added to the whole number given by the scale. If none of the divisions of the scale coincides exactly, we judge by the eye, in decimals, the quantity by which the vernier must be lowered to obtain a coincidence, and this is added to the fraction already obtained. This will be hundredths of millimetres in the metrical Barometer, and thousandths of inches in the English Barometers.

The following figures will serve as an example; the instrustrument is an English Barometer.

Fig. 6.

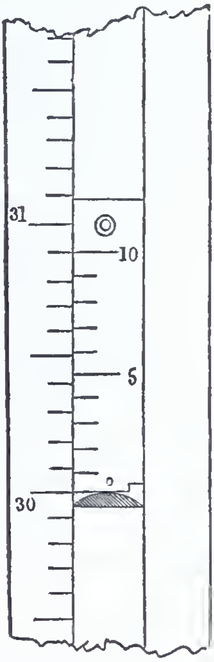


Fig. 7.

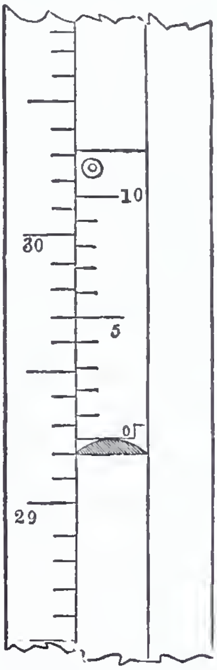
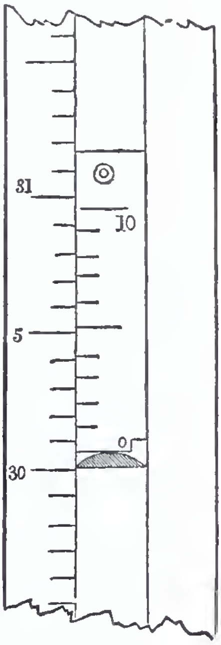


Fig. 8.



In fig. 6 the regulating line, which is the lower edge of the the vernier ring, coincides exactly with the line of thirty inches on the scale. The zero and the tenth division of the vernier are also in exact coincidence; that is to say, there is no fraction. We shall read then 30.000 inches.

In fig. 7 the regulating line does not fall upon any of the divisions of the scale, but between twenty-nine inches and two-tenths and twenty-nine inches and three-tenth of inches. There is then a fraction which must be read on the vernier. Seeking which of these divisions coincides with that of the scale, we find that it is the fifth; we shall write then 29.250 inches.

In fig. 8 we see that the height falls between thirty inches and thirty inches and one-tenth; no line of the vernier also coincides exactly; but the line 4 is a little above, the line 5 is a little below one of the lines of the scale; the fraction falls, then, between seven and eight hundredths. Estimating in tenths the distance the vernier passes over between the coincidence of seven and that of eight, we thus obtain the tenths of an hundredth, or the thousandths. In this latter case, the distance above seven is less than the half, we shall then read 30.073. It will always be easy to judge whether the top approaches nearer the upper coincidence than the lower coincidence; in the former case the fraction is greater than .005; in the latter it is smaller than .005. The error which will be committed in this estimate will remain less than .005; with practice and a little skill, it will hardly ever exceed .002, always supposing the scale is well graduated. For this reading, as well as for the others, it is particularly important to have the eye exactly at the height of the line to be determined.

The same process of reading is applied to the metrical scale; the vernier then gives tenths directly, and by estimate, the hundredths of millimetres. In the English instruments, the inches must be separated by a (.) and three decimals written, even when the last is a zero; ex. gr.: 30.250 and not 30.25; the zero indicates that the thousandths have been taken into account, but that there is none. In the metrical scale put the (.) after the millimetres, and admit two decimals, ex. g. 761.25.

During the whole time of the observation of the Barometer, the observer must endeavor to protect it as much as possible from the heat which radiates from his body. But the best way is to learn to observe rapidly. All the operations of which we have just spoken take longer to describe than to execute; one or two minutes, if the instrument be in place, three minutes, if it is to be taken from its case and put back again, are sufficient for a practised observer to make a good observation.

Altitude.—The height of the Barometer above the ground, or above some fixed point, which may serve as an invariable point of reference, ought to be exactly determined. Such a point, for instance, may be the base of a public edifice, the level of low water of a neighboring river, the ordinary level of the surface water of a canal, the upper part of a wharf in mason-work, &c. If the barometer has changed place, it is again necessary to measure exactly its height above the same point of reference; the latter will serve to fix the height of the Barometer and of the station above the level of the ocean; this *datum* being of the greatest importance. Every change of this nature should be carefully noted in the journal.

It is greatly to be desired that the place of the Barometer, once determined, should not be changed, either from one story to another, or from one house to another. If circumstances compel this to be done, we should begin, before taking it from its place, by raising the mercury in the cistern by means of the screw, so as to fill the cistern and the tube; it must then be gently taken from the hook, *turned upside down*, and carried with *the cistern up*, taking great care not to strike it against anything. If it were transported without these precautions, even from one chamber to another, great risk would infallibly be run of breaking it, or letting in air, and thus rendering it useless.

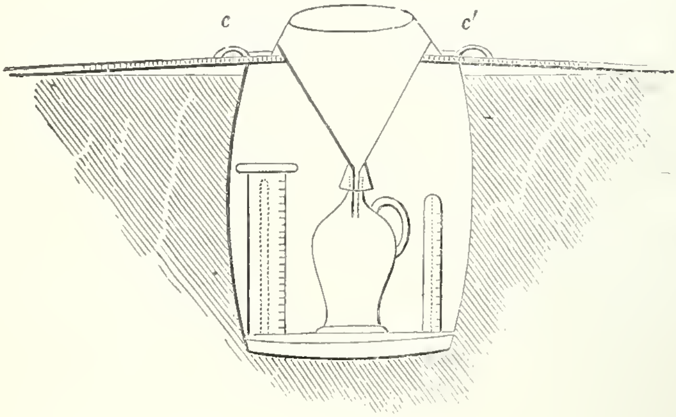
Verification.—From time to time the Barometer should be so inclined as to cause the mercury to strike gently against the top of the tube. If it gives a dry and clear sound, it is free from air, and the instrument is in good condition. If the sound is flat and muffled, there is a little air in the Barometric vacuum; and the fact should be noticed in the journal. Every occasion should be seized to compare it anew with a standard Barometer, to ascertain whether it has undergone any change.

OMBROMETER.

Placing.—The *Ombrometer*, or *Rain-gauge*, is a zinc funnel, accompanied by two graduated cylindrical glass vessels, and by a reservoir. It should be placed in an open space. Trees, high buildings, and other obstacles, if too near, may have a considerable influence in increasing or diminishing the quantity of rain which falls into the funnel. The surface of the receiver should be placed horizontally about six inches above the ground. The most simple mode of establishing it is the following:

Place in the ground a cask or barrel, (Fig. 9,) water-tight, the top rising above the ground about three inches; cover it with boards slightly inclined in the form of a roof, which project on all sides beyond the edge of the barrel at least a foot. A circular opening in the middle receives the funnel, the borders of which rest on the board. At the bottom of the barrel, to receive the water, is an earthen or metallic vessel, with a narrow neck, (an ordinary earthen jug will answer,) in which is placed the end of the funnel, exactly filling the opening. It must contain about three quarts, or a gallon. The funnel is fastened by means of two *clasps*, to the board, which must be covered up with sod, to make it like the ground itself. If circumstances render it necessary to place the Ombrometer higher, the height must be carefully noted in the journal. If it is placed upon a sloping roof, it should be on the top, and not at the edges, or at the angles, and must be raised several feet above the roof itself.

Fig. 9.



Observation.—To make the observation, remove the funnel, and pour the water from the jug into the large graduated glass cylinder. The opening of the funnel being one hundred square inches, one inch of rain in depth gives one hundred cubic inches of water; and each division of the glass containing a cubic inch of water, each of them represents a hundredth of an inch of rain fallen into the Ombrometer. These degrees are large enough to permit us to estimate the thousandths of an inch. The divisions of the smaller graduated glass cylinder will measure directly the thousandths of an inch, and it may serve, in case of accident, as a substitute for the larger one. The two glass vessels may be placed in the barrel itself, if it is of sufficient size. They must be placed in a reversed position, on two upright pegs, to let them drip out. As soon as the observation is made, it should be noted in pencil, not trusted to the memory; and written in the journal upon entering the house.

SNOW-GAUGE.

Observation.—The *Snow-gauge* should be supported vertically, in an open place, between three short wooden posts, its opening being about two feet from the ground. It should be employed in the following manner:

When only a very small quantity of snow falls, or of snow alternating with rain, or of dry and fine snow, driven by the wind, it should be collected in the Snow-gauge, as would be done in the Ombrometer. But when the snow falls in a sufficient quantity to cover the ground more than an inch deep, the vessel must be emptied, and plunged, mouth downwards, into the snow, until the rim reaches the bottom. A plate of tinned iron, or a small board, may then be passed between the ground and the mouth of the gauge, and the whole reversed. In this way a cylinder of snow, of which the base is superficially one hundred inches, will be cut out, and received into the vessel. The operation may be facilitated by placing on the ground a platform of strong board or plank, two or three feet square, on which the snow is received.

The place selected for this purpose must be one where the snow has not been heaped up, or swept away by the wind, and where it presents, as near as possible, the mean depth of the layer that has fallen. In order to take only the snow which may fall in the interval between two observations, the board should be swept after each measurement, and the place designated by stakes.

Reading.—In the reading of the graduated vessels, the general surface of the liquid must be considered as the true height, and not the edges, which are always raised along the walls of the vessel by capillary attraction.

The collected snow must be melted by placing the gauge, covered with a board, to prevent evaporation, in a warm room; and the quantity of water produced measured by pouring it into the glass cylinder. It need hardly be said, that if rain and snow fall the same day, no account will be taken except of what the Snow-gauge receives, unless the Ombrometer has been observed separately after the rain, and the Snow-gauge after the snow. Care must be taken, in these cases, not to count twice the same quantity of fallen water.

The rain-water and melted snow-water must be separately entered in the journal in the columns reserved for each.

During abundant rain-falls, it is well to measure the water more than once a day, or at least immediately after the rain; and the quantity of the rain fallen, together with the time it has lasted, is to be noted separately in the column of remarks.

When it freezes, it will be necessary to protect the receiver by filling in the interior of the barrel with straw.

WIND-VANE.

Placing.—The *Wind-vane* should be set in a place as free and open as possible, away from every obstacle and especially from high buildings. It should exceed in elevation, by at least eight or ten feet, the neighboring objects. To facilitate observations at night, the following arrangement may be adopted:

The wind vane is composed of a leaf of zinc about three feet in length, in the form of a butterfly's wing, exactly counterbalanced by a leaden ball. It is carried upon a cylindrical axis of pine wood, or of any other light and strong material, two inches in diameter, which, if possible, passes down through the roof into the observer's chamber, otherwise along the exterior wall of the building to a window. The axis terminates by a steel pivot turning freely on a cast-iron plate. This plate supports a dial divided into degrees, besides indicating the eight principal points of the compass. The axis carries an index placed in the same plane as the feather of the Wind-vane, which enables us to read upon the dial, as well by night as by day, the direction of the wind. The whole rests on a strong wooden shelf, firmly fastened to the window by supports. Above, the rod is firmly fixed to a strong upright staff, or, better, on the roof, with strong braces, by means of a piece of wood containing friction rollers, which allow the shaft to turn freely and without effort. Similar pieces with friction rollers, placed at different distances along the wall, keep the axis vertical.

Great care must be taken to secure the perfect verticality of the shaft, and to this end, it is necessary to fix it by a plumb line, in two different planes cutting each other at right angles. The index at the foot of the rod should be placed on the same side with the point of the Wind-vane, and in the same plane as the feather. The pivot should turn very freely in the hole that receives it, and into which a drop of oil should be poured.

Finally, we must carefully adjust the points of the dial, which is supported, with the iron plate, upon a board fastened upon a shelf by means of a strong screw. In making this adjustment by means of a compass, the magnetic variation of the locality must be taken into account; each observer should have the line of the true north traced on his window.

If the dial is exposed to the open air, it must be protected against the snow and ice, which would impede the play of the pivot and of the index. A small ring of wood placed around the pole, under one of the friction rollers, will prevent the Wind-vane from being raised, and the pivot from being displaced during the most violent winds.

Observation.—The observation of this instrument demands some care. In winds of considerable strength the vane is never at rest, or fixed in the same direction; it oscillates incessantly, and its oscillations increase in amplitude with certain winds, and with the violence of the wind. We must then note the mean direction between the extremes. When the wind is very feeble, perhaps it may not have sufficient force to set the vane in motion; in this case, as when the air is calm, great mistakes might be made by registering the direction marked by the index; for its position indicates, not the direction of the existing wind, but that of the last wind that had the power to set the instrument in motion. When the index is immoveable, and there is no oscillation, we must give up its indications, and refer to the movement of light bodies, as that of the leaves of trees and the smoke of chimneys, to determine the direction of these feeble currents of air. During the night, the direction of the wind may be easily ascertained by raising the hand in the air, with one finger wet. The least motion in the air increases evaporation, and a sensation of cold is experienced on the side of the finger turned towards the wind.

The *direction* of the wind must be noted, following the eight principal points of the compass, North, Northeast, East, Southeast, South, Southwest, West, and Northwest. For the additional observations during storms. the degrees may be indicated, in order to follow more exactly the rotation of the wind, or at least sixteen points of the compass, viz: N. NNE. NE. ENE. E. SE. ESE. SSE. S. SSW. SW. WSW. W. WNW. NW. NNW.

The lower, or surface wind often has a different direction from that which prevails in the upper regions of the atmosphere, and this is generally the case when the wind turns, and the weather is going to change, also during storms, and great atmospheric movements. The direction, then, of the lower and the higher layers of clouds must be separately noted in the several columns of the journal reserved for this purpose. If the direction is the same in the whole extent of the atmosphere, the same letters will be marked in the three columns. If the absence of clouds does not permit us to judge how the wind is above, a dash must be substituted for the letter, indicating that the observation has been made. A blank always signifies an observation omitted.

To avoid an error in the estimate of the direction of the clouds, it will be well to observe their course between two fixed points, as a window frame, the fixed lines of which will facilitate the observation. Another very convenient method is to place a small mirror horizontally, with lines traced on it indicating the points of the compass; the image of the clouds passing over these will indicate their direction.

The manner in which the wind turns, or rather the order in which the winds succeed each other in the course of the day must be watched very carefully. It will be seen that they commonly follow in regular order; they pass from the East by the South to the West, and from the West by the North to the East. Nevertheless, they sometimes go back in the opposite direction, particularly during storms. A little memorandum, summing up in a few words at the end of each day, this course of the wind, together with the hours of the wind's changes, is very valuable. It may be entered in the column of remarks, or in the Book of remarks.

The *force* of the wind must be estimated as nearly as possible according to the following degrees:

0. A perfect calm.

The simple initial letter of the wind, for instance N (north,) indicating its direction without any number, means a slight movement of the air hardly to be called a wind, and only just sufficient to allow an estimate of its direction.

1. A light breeze which moves the foliage, and sometimes fans the face.

2. A wind which moves the branches of the trees; somewhat retards walking, and causes more or less of a slight rustling sound in the open air.

3. A wind which causes strong boughs and entire trees to rock; makes walking against it difficult; which causes a stronger rustling sound to be heard, and which often blows in gusts, and carries light bodies up into the air.

4. A storm-wind, during which the trees are in constant motion; branches and boughs covered with foliage are broken off, and in a violent storm sometimes even entire trees are broken, or uprooted; leaves, dust &c. are continually borne up and carried far far away; during which there is an uninterrupted loud rustling

sound, with strong gusts; walking windward is extremely difficult; and now and then, chimneys, fences, &c. are thrown down, windows broken in, &c.

These degrees correspond nearly to the following numbers of Beaufort's scale, which is generally used among seamen:

1. the same as	1.	Light breeze,	of Beaufort's scale.
2. " " "	4.	Moderate breeze,	
3. " " "	8.	A fresh gale,	
4. " " "	11.	A storm-wind,	

SKY.

The blue color of the sky has an intimate connexion with the hygrometrical state and the electrical tension of the air; it may be noted by the expressions, *dark*, *light*, and *greyish*.

Haze and dry mist.—The transparency of the air is often disturbed by a kind of vapor, which gives a whitish tint to the sky and dims the rays of the sun. This phenomenon, known in Europe under different names, appears frequently after long droughts; in this country it seems to characterize the Indian summer. In Europe, and elsewhere, an intense dry mist, which is, probably, a different phenomenon, sometimes follows great earthquakes or volcanic eruptions. The observer will carefully enter phenomena of this kind, and the circumstances under which they appear or disappear. If he has an opportunity, as in a high station, he should endeavor to ascertain if there is an upper limit, and what is the thickness of the layer of haze or dry mist. Observations made in the Alps prove that the atmosphere is often entirely free from it at a height of two thousand feet, when it is very intense in the plain. Does a thunder-storm or rain always cause it to disappear? Do the prairie fires have any relation with kindred phenomena? Does it appear more frequently in certain seasons than in others?

HYDRO-METEOROLOGICAL PHENOMENA.

DEW.

The *dews*, especially when they are abundant, and

The *white frosts*, or frozen dew, particularly the first and last of the year, and their intensity, must be entered.

FOG.

Fog.—The moment must be noted when it forms and when it dissipates, as *falling* fog, *rising* fog; its density, as *dense* fog, *slight* fog.

Mists hanging over forests, moors, meadows, rivers, or the like. Notice must be carefully taken of the time of their appearance or disappearance; these are the most important facts in regard to them.

These fogs must not be confounded with the dry fog, which belongs to another class of phenomena, which have been spoken of above.

CLOUDS.

For noting these the observer must go out to a place entirely free, in case his residence has too confined a horizon.

The *cloudiness* or the quantity of clouds, after some practice, can be easily estimated, in accordance with the following scale. Thus, we understand by:

0. A clear sky, entirely free from clouds:
10. The whole sky covered with clouds, or a dense fog, or rain, and by 1, 2, 3, 4, 5, 6, 7, 8, 9, the different degrees of cloudiness which lie between these:
1. Denotes, for instance, nine times as much blue sky as clouds.
5. An equal amount of clouds and blue sky:
9. Nine times more clouds than blue sky.

If, on account of the locality, it is impossible for the observer to estimate the quantity of clouds in this way, he can make use of the following expressions, which will mark at the same time the medium character of the aspect of the sky during each day:

Wcl.	Wholly clear; a sky entirely free from clouds.
Cl.	Clear; when at least two-thirds of the sky is unclouded.
M.	Medium; the clouded part of the sky nearly equal to the blue.
C.	Cloudy; a larger part cloudy than clear.
Ov.	Overcast; the clouds rarely broken.
Cov.	Covered sky; without any visible spot of blue.

The form of the clouds will be indicated by the terminology of Howard.

According to this they are distinguish by their external forms into three kinds: the *cirrus*, *cumulus*, and the *stratus*, to which belong four transition forms, the *cirro-cumulus*, the *cirro-stratus*, the *cumulo-stratus*, and the *nimbus*. The annexed plates, I and II, represent the most remarkable of these forms, which may be characterized in the following manner:

The *cirrus*, or cat-tail of the sailors, is composed of loose filaments, the whole of which sometimes resembles a pencil, sometimes curly hair, sometimes a fine net, or a spider's web.

The *cumulus*, or summer cloud, the cotton bale of the sailors, often shows itself under the form of a hemisphere resting on a horizontal base. Sometimes these half spheres are piled upon one another forming those large accumulated clouds in the horizon which resemble at a distance mountains covered with snow.

The *stratus* is a horizontal band, which is formed at sunset and disappears at sunrise.

The *cirro-cumulus* are those small rounded clouds, which are often called fleecy; when the sky is covered with clouds of that kind it is said to be mottled.

The *cirro-stratus* is composed of small bands, formed of closer filaments than those of the cirrus, for the rays of the sun often find it difficult to penetrate them. These clouds form horizontal beds, which, at the zenith, seem composed of a great number of loose clouds, while at the horizon a long and very narrow band is seen.

The *cumulo-stratus* is a mass of heaped up and dense cumuli. At the horizon they often assume a dark or bluish tint, and pass into the condition of *nimbi*, or rain clouds.

The *nimbus* is distinguished by its uniform grey tint, its fringe and indistinct edges; the clouds composing it are so blended that it is impossible to distinguish them.

But besides these principal forms, there are several intermediate, to which it is difficult to assign a name. They must be referred to the form which they most resemble.

They may be entered in the journal by means of the following abbreviations:

St.	i. e.	Stratus.
Cu.	"	Cumulus.
Cir.	"	Cirrus.

Cir. st.	i. e.	Cirro-stratus.
Cu. st.	"	Cumulo-stratus.
Cir. cu.	"	Cirro-cumulus.
Nim.	"	Nimbus.

If several of these forms are visible, the most frequent should be underlined, and the others should follow the order of their frequency. The distribution of the clouds in the sky should be noted, whether they are dispersed or accumulated in a special region of the heavens, in the horizon, at the zenith, &c.

RAIN.

It is necessary to note as accurately as possible the hour at which the rain begins and ends, if it is a continued rain, or at intervals and in showers; if it is general or only partial, preceded, followed, or accompanied by fogs; the size of the drops and the force of the rain should be also noted. For these different cases, the following designations may be adopted:

Rainy, when the fall of some drops and the appearance of the weather is such as to indicate the approach of rain.

Continued rain.

Interrupted rain.

Shower, which lasts not more than a quarter of an hour.

General rain, which prevails over the whole extent of the horizon.

Partial rain, which falls from clouds that pass over only a small extent of country.

The force of the rain may be indicated by the following gradations:

Drizzling rain, which falls in very small drops, almost like those of mist.

Slight or fine rain.

Moderate rain.

Heavy rain.

Violent rain, heavy and strong pelting rain.

The size of the drops seems to depend chiefly upon the height of the clouds, and consequently upon the seasons and the circumstances of the temperature.

The *snow.*—The period of the first and last snow, the size of the flakes, their forms.

Sleet, which consists in small balls of snow, white and opaque, commonly without a crust of ice, like the opake nucleus found within hail stones, falling more frequently in spring and in autumn.

Frozen rain drops should be distinguished from the preceding forms; they make little balls of transparent ice.

Hail.—Indicate the size and form of the hailstones, the extent and course of the phenomenon.

THUNDER STORMS.

The time of beginning and ending of the storm must be indicated as exactly as possible; the point of the horizon whence it rises, the direction of the clouds, of the wind, and its variations, and, if possible, the quantity of rain before and during the storm; of hail, &c., which falls; note if it passes over the place of the observation, or at a distance; if it is accompanied, or not, with strong electrical detonations and numerous lightnings. It will be well to ascertain the state of the meteorological instruments during the storm, especially of the barometer and the thermometer.

In the journal, the occurrence of a storm will be indicated in the column of remarks, merely by the letters *Th St*, with the hour when it took place. If special observations have been made with the instruments, they will be entered on the opposite side of the sheet in the columns reserved for additional observations, taking care to note the day and the hour. If the observations require a more detailed description, it must be entered in the Book of remarks.

TORNADOES AND LAND-SPOUTS.

These whirlwinds, or violent and circumscribed storms give rise to very complex phenomena, which are difficult to observe. All the meteorological circumstances, however, should be minutely noted; among others the following:

The course of the barometer, which almost always sinks much and rapidly; that of the thermometer, which usually indicates an elevation of temperature; the region of the heavens in which the thunder storm frequently accompanying them, is formed; the the form and color of the clouds; the direction and intensity of the wind; the frequency, the size, and the form of the lightnings; finally, the apparent shape of the land-spout, its variations, its course, and its effects upon the trees and upon the ground. These observations may be inserted in the Book of remarks.*

ADDITIONAL OBSERVATIONS DURING STORMS.

Everybody knows the importance of a knowledge of the laws of those great movements of the atmosphere which embrace almost the whole extent of the continent. It is only in following, them step by step: by observing their different phases at different places, and by combining the facts obtained, that the meteorologist can be enabled to discover the laws which preside over these great phenomena. For this, the three regular observations a day are insufficient; it is then earnestly recommended to observers, who desire to contribute effectually to the solution of this great problem, not to content themselves with the prescribed number, but to add as many more as possible during the continuance of remarkable storms; noting not only the state of the instruments from hour to hour, if possible, but following with attention all the meteorological changes. These observations must be entered on the reverse of the sheet, under the head of *additional observations*, which is particularly reserved for this purpose.

The principal points to which attention should be directed are the following:

The *Barometer* announces by a considerable fall the approach of a storm. Then it begins to rise during its continuance, and only resumes its nominal equilibrium after its close. Remark especially the following points:

Was the storm preceded by a noticeable or sudden rise previous to the fall.

Note the state of the Barometer, and the time when the fall becomes more rapid;

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* For more detailed instructions upon the observations of land spouts, see the Annuaire Météorol. de France., 1849, p. 225.

Its state, and the time, when it is lowest and when the rise begins;

The highest point which it reaches during, or immediately after the storm.

If alternations of rising and falling take place, the fact should be mentioned and the time noted.

The Thermometer.—The fluctuations of the Thermometer in the same time as those of the Barometer should also be noted, and their connexion with the changes of the wind be observed.

The Wind.—It is of the greatest importance to observe the course of the winds through the entire height of the atmosphere during the whole continuance of the storm, by means of the wind vane and of the clouds in the different layers of the atmosphere.

The hour when the wind begins, and the direction whence it comes.

The moment of its greatest violence.

The instant it changes its direction, and when it takes the direction it keeps to the end of the storm.

It should be stated if the wind blows in a continuous manner or in squalls, and what is its force.

If there should be one or more moments of calm, the hour and duration will be indicated.

Great care must be taken at each observation to note also the direction of the different layers of clouds, which will very often be found different from that of the wind below, for the whole duration of the storm.

The Clouds.—Are there certain forms of clouds which announce the approach of a storm? It is necessary, in this connexion, to watch the formation of the cirrus, the cirro-cumulus, cirro-stratus, their arrangement in parallel lines, their course, and their directions. Note the quarter of the sky first covered with clouds; the moment when it is entirely covered; if there are later clear spots or not; the moment when the sky clears off.

The Rain.—Note the hour at which the rain or the snow begins and ends; measure the quantity fallen while the storm lasts.

ACCIDENTAL METEORIC PHENOMENA.

These will be entered in the tables, in the place reserved for this purpose on the opposite side of the sheet. If the space is not sufficient for the description to be given, the phenomenon should be simply noted, and reference made to the book of remarks for details. Thus:

The solar and lunar halos, that is, the colored circles sometimes observed round the sun and moon. Distinguish the small ones, the ring of which measures only a few degrees, from the large or real halos, the ring of which has a diameter of about forty-four degrees. It must be stated whether they are connected with other circles, as is sometimes the case. Care must be taken not to mistake a part of a grand halo for a rainbow. Note whether these appearance are, or are not, ordinarily followed by rain.

The Parhelia and Paraselenes (*Mock-suns and Moons.*)—Describe exactly their forms and the state of the heavens at the moment of their appearance.

Rainbows, simple or double.

An extraordinary *redness* of the sky, either in the morning or evening; the particular color of the sun and of the moon at their rising, especially in fair days.

Heat lightnings without thunder, and sometimes without clouds; indicate their direction, and the aspect of the clouds in their neighborhood.

The *Aurora Borealis*, or Northern Light, for the observation of which the special instructions published by the Smithsonian Institution must be followed.

Shooting-stars.—The observer must be particularly attentive to their frequency, during the periods near the 10th and 11th of August, and the 10th and 15th November, in which it is supposed that they are more numerous than at any other time. He will designate the quarter of the heavens from which they seem to issue, and their direction.

Fireballs.—Describe their aspect, their size, their course in the heavens, and note the exact hour of their appearance.

All the other luminous phenomena, which present any extraordinary appearance, should be noted down.

These descriptions should be made in simple and well defined terms. The observer will take great care to enter scrupulously *what he sees*, without drawing any conclusion, or attempting any explanation of the phenomenon. He ought to reflect that, in order to make a good observation, he must keep his mind in a state of perfect disinterestedness in respect of any preconceived theory, and to consider the phenomenon before him as being one of the data for the foundation of the science, and that the knowledge of the truth will depend upon the fidelity of his observation.

TIME OF OBSERVATIONS.

The time of observations will be the mean time at each station. The observations will be made three times daily, viz:

At 6 o'clock, A. M.
" 2 " P. M.
" 10 " P. M.

The mean of these three hours will be very nearly the true mean, as it would be obtained by observation made every hour of the day and night. They are at intervals of eight hours from each other, and are the least inconvenient possible for the daily occupations of life; they must be preferred to any other series of three equidistant hours.

The Ombrometer will be observed only once a day, unless very abundant rains should make a second measurement necessary. The best time will be 2 o'clock, P. M., the observation being made daily; if another hour is selected, it should, when once fixed, remain the same.

The maxima and minima Thermometers will be read once a day, always at the same hour. The most suitable hour will be 10 o'clock in the evening.

If an observer desires to examine the daily oscillations of the Barometer he will also observe at 10, A. M., and 4, P. M., which give the daily maximum and minimum. It will be well to note also, at the same time, the state of the Hygrometer.

If he desires to complete the data upon the diurnal course of the temperature, he will add observations of the Thermometer at 10, A. M., and 6, P. M. In all cases it is desirable that, if an observer has leisure to increase the number of the hours of observations, he should fix them at equal intervals between the principal hours indicated above.

Besides these observations at regular hours, additional observations ought to be made during remarkable storms, as has been remarked above.

It is very important that the observations should be made at the exact hour, fixed by a well regulated watch. All the instruments should be read rapidly, so that the observations may be as simultaneous as possible.

The order in which they are to be observed will be as follows:

A few minutes before the hour, observe the Thermometer before opening the window; then wet the Psychrometer. While it is taking the temperature of evaporation, note the height of the Barometer, observe the wind, the course of the clouds, their quantity, the aspect of the sky, &c.; then read the temperature of the Psychrometer.

The observations must be recorded for each instrument at the moment when they are made, without trusting any thing to the memory. A strict rule should be laid down for one's self, to note exactly the indications of the instruments, without subjecting them mentally to any corrections or any reductions; these should not be applied until all the elements are at hand.

If the observer has been unavoidably hindered from making the observations at the exact hour, he will note in the column of hours the number of minutes of the delay. If he is obliged to procure a substitute, he must choose one accustomed to this kind of observation; but before entering his records, he will carefully examine them. To distinguish the observations made by his substitute he will enter them in red ink.

As it is of the greatest importance that the series of observations should not be interrupted, and that there should be no omissions, each observer will do well to instruct beforehand one or more substitutes, who may be able upon occasion to take his place. If in spite of these precautions the observation has necessarily been omitted, its place will be left blank in the journal. In this case the observer must never fill up these blanks with calculations, according to his judgment; he should consider the conscientious observance of this rule indispensable to truth and good faith. He should remember, besides, that if he acts differently, he not only lessens the value of these results, but brings into doubt and disfavor the fidelity of his other observations, and takes from them what constitutes their greatest value for science, *confidence.*

JOURNAL.

The *Journal* is composed of engraved Blank forms for the register, and a Book of remarks. The former are intended for daily observations; the latter to receive the more detailed descriptions of remarkable or accidental phenomena; or tables of general results; comparisons with the observations made in the preceding years at the stations, or in other places, &c.

The *Register.*—In the register the first page is devoted to regular observations, the second to additional observations, to periodical or extraordinary phenomena, and to monthly recapitulations. The headings of the columns indicate clearly the use of each.

For each instrument the columns follow each other in the order in which the observations are to be made, and one column is reserved to enter the observation *just as it is made,* and before any correction or reduction. As each sheet is to be regarded as an independent document, it should carry with it all that is necessary to correct the observations therein contained, and to render them authentic. Thus, the date of the year, the month, the precise locality, the latitude and longitude, the elevation of the instruments from the ground and above the sea, the nature and condition of the instruments which have been employed, and the amount of their corrections; finally, the signature of the observer should be repeated on every leaf. It will be sufficient, for this, to fill the blank spaces left after the different printed titles in the Blank forms. The observer should the less neglect this important duty, as it is an affair of only a few strokes of the pen each month, without which his labor would run the hazard of losing its value.

The Thermometer.—In the thermometrical observations the quantities above zero will be *always* written without a sign; the negative quantities will be all *individually* marked with the sign *minus*, (—,) whether they follow each other or are isolated. In the first column, entitled *daily mean* will be inscribed the mean of the three observations of the day, i. e. their sum divided by 3, admitting two decimals. In the second column of the daily mean will be inscribed the mean of the maximum and the minimum, given by the Thermometrograph, or self-registering Thermometers.

Barometer.—The degree of the attached Thermometer and the observed height of the Barometer will be inscribed in the first two columns. This height will be reduced to freezing point, or 32° Fahrenheit, or zero Centigrade, by means of the annexed tables, and the whole correction of the instrument, indicated on the back of the sheet, will be applied to it. It will then be inscribed in the third column, entitled *corrected height* at freezing point. These corrected heights, and never any others, must be employed to form the mean, which will be inscribed in the fourth column.

Psychrometer.—In the first two columns will be entered the indications of the dry and wet Thermometer, after having applied to each of them the correction of the instruments, if there be any; and in the third column the difference of the two numbers. By means of the Psychrometrical tables will be found the *force of the vapor* and the degree of *relative moisture*, each of which has its column, as well as the daily means of each of these elements.

We have indicated above the manner of noting the *direction* of the winds.

As to the *force* of the *surface* wind, which alone can be estimated with some degree of precision, it will be expressed by adding to the letter which designates the direction, the figure indicating its force: e. g. N, without a figure, signifies a slight air, hardly perceptible, coming from the North; N_1, a slight breeze; N_3, a strong wind, &c. The other two columns will have only letters, or a dash (—) if the observation has not been possible.

The quantity of clouds, or the *cloudinesss* estimated from zero, or a perfectly clear sky, to 10, sky entirely overcast, has a separate column.

It is the same with *rain* and *melted snow*, which will be separately entered. A third column is reserved for the total quantity of both. The thickness of the layer of fallen snow may be indicated in inches and tenths, in the column of remarks.

Finally, it is desirable to enter in a last column the position of the *moon*, according to the almanac, with the usual signs, a model of which is found at the bottom of the blank forms.

As to the broad column reserved for the *aspect of the sky, and remarks*, although it is desirable, considering the small space the form of the table allows, to employ abbreviations to express the state of the sky and the different meteorological phenomena; nevertheless, we must limit ourselves to a small number, chosen from among the expressions which most frequently occur, such as those found at the bottom of the blank forms. If abbreviations are too much multiplied, we lose in clearness and certainty what we gain in conciseness. A meteorological journal should not resemble a page of algebra, where a badly formed letter or a misplaced sign render the expression unintelligible.

For the additional observations the same rule should be followed.

In the space reserved for *Periodical and extraordinary phenomena*, the phenomena will be inscribed with their dates and the hour of their appearance, referring, as we have already said, to the Book of remarks for a detailed description, citing the page.

Every change of position, or in the condition of the instruments, should be carefully entered under the head of *Condition of the instruments*, destined for this, with the precise date at which it took place. If there has been none, *instruments all in order* will be entered. By the side of the indication of the correction of the instruments will be placed, *corr. applied*, or *corr. not applied*, according as the observations contained in the sheet shall have been corrected or not. The finished sheet will be signed by the observer.

The *reductions*, the *corrections*, and the *calculations of means*, must be made day by day and at the end of each month with the greatest punctuality. The necessary tables will be placed at hand by the side of the journal, and each observation reduced, and the correction, if any, applied immediately.

This is not only the least troublesome method, but the only one which permits the observer to control the observations and the reductions, and to discover the accidental errors of the pen and of the reading in the record.

The observer cannot be too thoroughly convinced that a meteorological journal which contains only rough observations, is only half made; in this condition it is wholly unfit to serve any scientific purpose. The observations cannot be compared rigorously with each other, nor with those of other stations. The only means for the observer to give its true value to his labor, is to make the corrections, the reductions, and the calculations of the means himself. It is for want of having thus been elaborated that voluminous collections of observations, the fruits of long years of toil, remain useless and forgotten in the dust of libraries, because the meteorologist finds it impossible to make use of them without first undertaking those calculations, the amount of which absolutely transcends the powers of an individual, and would discourage the most ardent zeal, while they would have cost the observer only an instant each day, if he had made them at the time of the observations.

The calculations required of the observer are as follows:

1. Each barometrical observation must be reduced immediately to the temperature of zero Centigrade, or 32° Fahrenheit, by means of the tables,and the total correction of the barometer, if there is any, will be applied.

2. The diurnal means of the several instruments, resulting from the sum of the three observations made at these different hours, divided by three, must be entered each day in the respective columns, after the observation of 10 P. M. It is needless to say that these means should be drawn solely from observations reduced and corrected.

3. The mean of the same instruments must be taken for every

ten days. In the spaces reserved in the table will be entered the sum resulting from the addition of the observations of the ten days, as well as the mean itself. The mean is simply taken by moving back the decimal point one figure; for instance, the sum being 678.5 degree Fahrenheit, the mean will be 67.85. When the month has more or less than 30 days, the last set contains from 8 to 11 days; the sum, then, will be divided by the number of days which actually compose the set, 8, 9, or 11.

4. The monthly means for each hour separately, that is, the monthly mean of the observations of 6 A. M., that of 2 P. M., and of the observations of 10 P. M.

5. The monthly means drawn from the means of each day; the monthly extremes of the instruments; the monthly amount of the rain, hail, or snow; the mean cloudiness of the sky; the prevailing wind, &c.

6. The annual means and amounts, and the respective extremes for the civil year.

It will be interesting to calculate also, if the observer is so disposed, the mean of the seasons of the meteorological year, which begins December 1, to November 30, of the following civil year:

The meteorological seasons are, then:

Winter — December, January, February.
Spring — March, April, May.
Summer—June, July, August.
Autumn—September, October, November.

In calculating all these different results, we should take, in order to be very exact, the means of the sums of all the observations during the period of time in question, by reason of the inequality of the length of the months.

The sums which form the basis of all these means should be inscribed in the tables in the place reserved for them.

The preceding calculations, after a little practice, will not appear difficult, and may be quickly performed; but it can hardly be too often urged upon the observer to make them without delay; otherwise, this task, which is slight if accomplished daily, would become very heavy, if left to accumulate for several months. It is only by making the corrections himself that the observer can institute his own comparisons, and really study the course of the meteorological phenomena. His interest will increase still more with the feeling that he is coöperating in a great work, which concerns at once his whole country and the science of the world, and the success of which depends upon the accuracy, fidelity, and devotion of all who take part in it.

A copy of the observations of each month must be forwarded for publication during the first week of the following month. It should be carefully collated by two persons, one of whom reads the figures aloud. Each observer will receive for this purpose a double series of blank forms, one of which will be retained by him. The Book of Remarks will be sent at the close of each year, and returned after inspection.

Many of the phenomena connected with the state of the atmosphere are of great interest for comparative climatology, especially in a practical point of view. The periodical phenomena of vegetation and of the animal kingdom, such as the epoch of the appearance and the fall of the leaves, of the flowering and ripening of the more generally cultivated fruits; the seed time and harvest of plants; the coming and going of migratory birds; the first cry of the frogs, the appearance of the first insects, &c.; the moment of the closing of rivers, lakes, and canals by ice, and of their opening; the temperature of springs at different periods of the year; the temperature in the sun compared to that observed in the shade; that of the surface, and that below the surface of the ground. All observations of this kind are valuable, and may be entered in the tables, if there is room, or in the Book of Remarks.

The observer will find it very instructive to project curves which indicate the diurnal monthly or annual variations of temperatures, of atmospheric pressure, of moisture, &c., as well as thermometrical, barometrical, compasses, &c.

These graphic representations are of the greatest utility for the comparisons, speaking to the eye more clearly than simple figures.

Besides the above directions for keeping an ordinary Meteorological Journal, more special instructions for the study of peculiar meteorological phenomena are prepared or preparing by the Smithsonian Institution, as on

Thunder-storms, Tornadoes, and Water-spouts, Aurora Borealis, Parhelia, Parasalenes, Haloes, Rainbows, Temperature of the soil, Periodical phenomena of the vegetable and animal kingdoms, graphic representations of meteorological phenomena, &c. If any observer should feel inclined to devote himself to the study of any one of these physical problems, he may receive, on application, the special instructions relating to the point which he wishes to investigate.

A. GUYOT.

Cambridge, May 1, 1850.

TABLE VIII.

Correction to be added to English Barometers for Capillary Action.

Diameter of Tube.	Correction for	
	Unboiled Tubes.	Boiled Tubes.
Inch.	Inch.	Inch.
0.60	0.004	0.002
0.50	0.007	0.003
0.45	0.010	0.005
0.40	0.014	0.007
0.35	0.020	0.010
0.30	0.028	0.014
0.25	0.040	0.020
0.20	0.060	0.029
0.15	0.088	0.044
0.10	0.142	0.070

TABLE IX.

GIVING THE CORRECTION

TO BE APPLIED TO

BAROMETERS WITH BRASS SCALES,

EXTENDING FROM

THE CISTERN TO THE TOP OF THE MERCURIAL COLUMN,

TO REDUCE THE

OBSERVATION TO THIRTY-TWO DEGREES FAHRENHEIT.

This Table is that adopted by the Committee of Physics and Meteo-ology of the Royal Society of London. It gives immediately the cor-ection for each degree Fahrenheit, and for each half of an inch from 20 up to 31 inches.

Examples of Calculation.

Barometer: observed height - - - - -	30.231
Attached Thermometer - - - - - -	+82.0

See, in the last page, the column of 30 inches; go down as far as the horizontal line corresponding with 82° in the first vertical column, which contains the temperature, you will find there the correction — .143. We have thus:

Barometer: observed height - - - - -	30.231
Substractive correction for 82.0° Fahr. - - -	—0.143
Barometer at 32° Fahr. - - - -	30.088

Barometer: observed height - - - - -	29.743
Attached Thermometer 25° Fahr.	
The column of 29.5 inches opposite to 25° Fahr. gives an *additive* correction of - - - - - -	+0.009
Barometer at - - - - - -	29.752

It will be easy to apply also the correction for fractions of degree Fahr. Ex. gr.

Barometer: observed height - - - - -	28.358
Attached Thermometer 71.3.	
In the column of 28.5 inches, we find that the difference between the correction for 71° and that for 72° is .003; dividing this difference proportionally to the fraction, we have for 71.03 a correction of .108+.001, or - - - - - - - - - -	—0.109
And Barometer at 32° Fahr. - - - - -	28.239

TABLE IX.

Temp. F.	Inches.								Temp. F.
	20	20.5	21	21.5	22	22.5	23	23.5	
	+	+	+	+	+	+	+	+	
0°	.051	.053	.054	.055	.056	.058	.059	.060	0°
1	.049	.051	.052	.053	.054	.056	.057	.058	1
2	.048	.049	.050	.051	.052	.054	.055	.056	2
3	.046	.047	.048	.049	.050	.052	.053	.054	3
4	.044	.045	.046	.047	.048	.050	.051	.052	4
5	.042	.043	.044	.045	.046	.048	.049	.050	5
6	.040	.042	.042	.044	.044	.046	.047	.048	6
7	.039	.040	.041	.042	.042	.044	.044	.046	7
8	.037	.038	.039	.040	.041	.041	.042	.043	8
9	.035	.036	.037	.038	.039	.039	.040	.041	9
10	.033	.034	.035	.036	.037	.037	.038	.039	10
11	.031	.032	.033	.034	.035	.035	.036	.037	11
12	.030	.030	.031	.032	.033	.033	.034	.035	12
13	.028	.029	.029	.030	.031	.031	.032	.033	13
14	.026	.027	.027	.028	.029	.029	.030	.031	14
15	.024	.025	.026	.026	.027	.027	.028	.029	15
16	.022	.023	.024	.024	.025	.025	.026	.026	16
17	.021	.021	.022	.022	.023	.023	.024	.024	17
18	.019	.019	.020	.020	.021	.021	.022	.022	18
19	.017	.018	.018	.018	.019	.019	.020	.020	19
20	.015	.016	.016	.016	.017	.017	.018	.018	20
21	.014	.014	.014	.015	.015	.015	.015	.016	21
22	.012	.012	.012	.013	.013	.013	.013	.014	22
23	.010	.010	.010	.011	.011	.011	.011	.012	23
24	.008	.008	.009	.009	.009	.009	.009	.010	24
25	.006	.007	.007	.007	.007	.007	.007	.007	25
26	.005	.005	.005	.005	.005	.005	.005	.005	26
27	.003	.003	.003	.003	.003	.003	.003	.003	27
28	.001	.001	.001	.001	.001	.001	.001	.001	28
	—	—	—	—	—	—	—	—	
29	.001	.001	.001	.001	.001	.001	.001	.001	29
30	.003	.003	.003	.003	.003	.003	.003	.003	30
31	.005	.005	.005	.005	.005	.005	.005	.005	31
32	.006	.006	.007	.007	.007	.007	.007	.007	32
33	.008	.008	.008	.009	.009	.009	.009	.010	33
34	.010	.010	.010	.011	.011	.011	.011	.012	34
35	.012	.012	.012	.013	.013	.013	.013	.014	35
36	.013	.014	.014	.014	.015	.015	.016	.016	36
37	.015	.016	.016	.016	.017	.017	.018	.018	37
38	.017	.017	.018	.018	.019	.019	.020	.020	38
39	.019	.019	.020	.020	.021	.021	.022	.022	39
40	.021	.021	.022	.022	.023	.023	.024	.024	40
41	.022	.023	.024	.024	.025	.025	.026	.026	41
42	.024	.025	.025	.026	.027	.027	.028	.028	42
43	.026	.027	.027	.028	.029	.029	.030	.031	43
44	.028	.029	.029	.030	.031	.031	.032	.033	44
45	.030	.030	.031	.032	.033	.033	.034	.035	45
46	.031	.032	.033	.034	.035	.035	.036	.037	46
47	.033	.034	.035	.036	.036	.037	.038	.039	47
48	.035	.036	.037	.038	.038	.039	.040	.041	48
49	.037	.038	.039	.040	.040	.041	.042	.043	49
50	.038	.039	.040	.041	.042	.043	.044	.045	50

TABLE IX—Continued.

Temp. F.	Inches.								Temp. F.
	20	20.5	21	21.5	22	22.5.	23	23.5	
51°	.040	.041	.042	.043	.044	.045	.046	.047	51°
52	.042	.043	.044	.045	.046	.047	.048	.049	52
53	.044	.045	.046	.047	.048	.049	.050	.052	53
54	.046	.047	.048	.049	.050	.051	.052	.054	54
55	.047	.049	.050	.051	.052	.053	.055	.056	55
56	.049	.050	.052	.053	.054	.055	.057	.058	56
57	.051	.052	.054	.055	.056	.057	.059	.060	57
58	.053	.054	.055	.057	.058	.059	.061	.062	58
59	.055	.056	.057	.059	.060	.061	.063	.064	59
60	.056	.058	.059	.061	.062	.063	.065	.066	60
61	.058	.060	.061	.062	.064	.065	.067	.068	61
62	.060	.061	.063	.064	.066	.067	.069	.070	62
63	.062	.063	.065	.066	.068	.069	.071	.072	63
64	.063	.065	.067	.068	.070	.071	.073	.075	64
65	.065	.067	.068	.070	.072	.073	.075	.077	65
66	.067	.069	.070	.972	.074	.075	.077	.079	66
67	.069	.071	.072	.074	.076	.077	.079	.081	67
68	.071	.072	.074	.076	.078	.079	.081	.083	68
69	.072	.074	.076	.078	.080	.081	.083	.085	69
70	.074	.076	.078	.080	.082	.083	.085	.087	70
71	.076	.078	.080	.082	.083	.085	.087	.089	71
72	.078	.080	.082	.084	.085	.087	.089	.091	72
73	.079	.081	.083	.085	.087	.089	.091	.093	73
74	.081	.083	.085	.087	.089	.091	.093	.095	74
75	.083	.085	.087	.089	.091	.093	.095	.098	75
76	.085	.087	.089	.091	.093	.095	.097	.100	76
77	.087	.089	.091	.093	.095	.097	.100	.102	77
78	.088	.091	.093	.095	.097	.099	.102	.104	78
79	.090	.092	.095	.097	.099	.101	.104	.106	79
80	.092	.094	.096	.099	.101	.103	.106	.108	80
81	.094	.096	.098	.101	.103	.105	.108	.110	81
82	.095	.098	.100	.103	.105	.107	.110	.112	82
83	.097	.100	.102	.104	.107	.109	.112	.114	83
84	.099	.101	.104	.106	.109	.111	.114	.116	84
85	.101	.103	.106	.108	.111	.113	.116	.118	85
86	.103	.105	.108	.110	.113	.115	.118	.120	86
87	.104	.107	.109	.112	.115	.117	.120	.123	87
88	.106	.109	.111	.114	.117	.119	.122	.125	88
89	.108	.111	.113	.116	.119	.121	.124	.127	89
90	.110	.112	.115	.118	.121	.123	.126	.129	90
91	.111	.114	.117	.120	.122	.125	.128	.131	91
92	.113	.116	.119	.122	.124	.127	.130	.133	92
93	.115	.118	.121	.124	.126	.129	.132	.135	93
94	.117	.120	.122	.125	.128	.131	.134	.137	94
95	.118	.121	.124	.127	.130	.133	.136	.139	95
96	.120	.123	.126	.129	.132	.135	.138	.141	96
97	.122	.125	.128	.131	.134	.137	.140	.143	97
98	.124	.127	.130	.133	.136	.139	.142	.145	98
99	.125	.129	.132	.135	.138	.141	.144	.147	99
100	.127	.130	.134	.137	.140	.143	.146	.150	100

TABLE IX—CONTINUED.

Temp. F.	Inches.								Temp. F.
	24	24.5	25	25.5	26	26.5	27	27.5	
°	+	+	+	+	+	+	+	+	°
0	.061	.063	.064	.065	.067	.068	.069	.071	0
1	.059	.061	.062	.063	.064	.065	.067	.068	1
2	.057	.058	.060	.061	.062	.063	.064	.066	2
3	.055	.056	.057	.059	.060	.061	.062	.063	3
4	.053	.054	.055	.056	.057	.058	.059	.061	4
5	.051	.052	.053	.054	.055	.056	.057	.058	5
6	.049	.050	.051	.052	.053	.054	.055	.056	6
7	.046	.047	.048	.049	.050	.051	.052	.053	7
8	.044	.045	.046	.047	.048	.049	.050	.051	8
9	.042	.043	.044	.045	.046	.046	.047	.048	9
10	.040	.041	.042	.042	.043	.044	.045	.046	10
11	.038	.039	.039	.040	.041	.042	.042	.043	11
12	.036	.036	.037	.038	.039	.039	.040	.041	12
13	.033	.034	.035	.036	.036	.037	.038	.038	13
14	.031	.032	.033	.033	.034	.035	.035	.036	14
15	.029	.030	.030	.031	.032	.032	.033	.033	15
16	.027	.028	.028	.029	.029	.030	.030	.031	16
17	.025	.025	.026	.026	.027	.027	.028	.028	17
18	.023	.023	.024	.024	.025	.025	.925	.026	18
19	.021	.021	.021	.022	.022	.023	.023	.024	19
20	.018	.019	.019	.020	.020	.020	.021	.021	20
21	.016	.017	.017	.017	.018	.018	.018	.019	21
22	.014	.014	.015	.015	.015	.016	.016	.016	22
23	.012	.012	.012	.013	.013	.013	.013	.014	23
24	.010	.010	.010	.010	.011	.011	.011	.011	24
25	.008	.008	.008	.008	.008	.008	.009	.009	25
26	.005	.006	.006	.006	.006	.006	.006	.006	26
27	.003	.003	.003	.003	.004	.004	.004	.004	27
28	.001	.001	.001	.001	.001	.001	.001	.001	28
	—	—	—	—	—	—	—	—	
29	.001	.001	.001	.001	.001	.001	.001	.001	29
30	·003	.003	.003	.004	.004	.004	.004	.004	30
31	.005	.006	.006	.006	.006	.006	.006	.006	31
32	.008	.008	.008	.008	.008	.008	.008	.009	32
33	.010	.010	.010	.010	.011	.011	.011	.011	33
34	.012	.012	.012	.013	.013	.013	.013	.014	34
35	.014	.014	.015	.015	.015	.015	.016	.016	35
36	.016	.017	.017	.017	.017	.018	.018	.019	36
37	.018	.019	.019	.019	.020	.020	.021	.021	37
38	.020	.021	.021	.022	.022	.023	.023	.023	38
39	.023	.023	.024	.024	.024	.025	.025	.026	39
40	.025	.025	.026	.026	.027	.027	.028	.028	40
41	.027	.027	.028	.029	.029	.030	.030	.031	41
42	.029	.030	.030	.031	.031	.032	.033	.033	42
43	.031	.032	.032	.033	.034	.034	.035	.036	43
44	.033	.034	.035	·035	.036	.037	.037	.038	44
45	.035	.036	.037	.038	.038	.039	.040	.041	45
46	.038	.038	.039	.040	.041	.042	.042	.043	46
47	.040	.041	.041	.042	.043	.044	.045	.046	47
48	.042	.043	.044	.045	.045	.046	.047	.048	48
49	.044	.045	.046	.047	.048	.049	.050	.005	49
50	.046	.047	.048	.049	.050	.051	.052	.053	50

TABLE IX—Continued.

Temp. F.	Inches.								Temp. F.
	24	24.5	25	25.5	26	26.5	27	27.5	
°	—	—	—	—	—	—	—	—	°
51	.048	.049	.050	.051	.052	.053	.054	.055	51
52	.050	.052	.053	.054	.055	.056	.057	.058	52
53	.053	.054	.055	.056	.057	.058	.059	.060	53
54	.055	.056	.057	.058	.059	.060	.062	.063	54
55	.057	.058	.059	.060	.062	.063	.064	.065	55
56	.059	.060	.061	.063	.064	.065	.066	.068	56
57	.061	.062	.064	.065	.066	.068	.069	.070	57
58	.063	.065	.066	.067	.069	.070	.071	.073	58
59	.065	.067	.068	.070	.071	.072	.074	.075	59
60	.068	.069	.070	.072	.073	.075	.076	.077	60
61	.070	.071	.073	.074	.075	.077	.078	.080	61
62	.072	.073	.075	.076	.078	.079	.081	.082	62
63	.074	.076	.077	.079	.080	.082	.083	.085	63
64	.076	.078	.079	.081	.082	.084	.086	.087	64
65	.078	.080	.082	.083	.085	.086	.088	.090	65
66	.080	.082	.084	.085	.087	.089	.090	.092	66
67	.083	.084	.086	.088	.089	.091	.093	.095	67
68	.085	.086	.088	.090	.092	.094	.095	.097	68
69	.087	.089	.090	.092	.094	.096	.098	.100	69
70	.089	.091	.093	.095	.096	.098	.100	.102	70
71	.091	.093	.095	.097	.099	.101	.102	.104	71
72	.093	.095	.097	.099	.101	.103	.105	.107	72
73	.095	.097	.099	.101	.103	.105	.107	.109	73
74	.097	.099	.102	.104	.106	.108	.110	.112	74
75	.100	.102	.104	.106	.108	.110	.112	.114	75
76	.102	.104	.106	.108	.110	.112	.114	.117	76
77	.104	.106	.108	.110	.112	.115	.117	.119	77
78	.106	.108	.110	.113	.115	.117	.119	.122	78
79	.108	.110	.113	.115	.117	.119	.122	.124	79
80	.110	.113	.115	.117	.119	.122	.124	.126	80
81	.112	.115	.117	.119	.122	.124	.126	.129	81
82	.114	.117	.119	.122	.124	.126	.129	.131	82
83	.117	.119	.121	.124	.126	.129	.131	.134	83
84	.119	.121	.124	.126	.129	.131	.134	.136	84
85	.121	.123	.126	.128	.131	.133	.136	.139	85
86	.123	.126	.128	.131	.133	.136	.138	.141	86
87	.125	.128	.130	.133	.136	.138	.141	.143	87
88	.127	.130	.133	.135	.138	.141	.143	.146	88
89	.129	.132	.135	.137	.140	.143	.146	.148	89
90	.131	.134	.137	.140	.142	.145	.148	.151	90
91	.134	.136	.139	.142	.145	.148	.150	.153	91
92	.136	.139	.141	.144	.147	.150	.153	.156	92
93	.138	.141	.144	.147	.149	.152	.155	.158	93
94	.140	.143	.146	.149	.152	.155	.157	.161	94
95	.142	.145	.148	.151	.154	.157	.160	.163	95
96	.144	.147	.150	.153	.156	.159	.162	.165	96
97	.146	.149	.152	.156	.159	.162	.165	.168	97
98	.148	.152	.155	.158	.161	.164	.167	.170	98
99	.151	.154	.157	.160	.163	.166	.169	.173	99
100	.153	.156	.159	.162	.165	.169	.172	.175	100

TABLE IX—Continued.

Temp. F.	Inches.							Temp. F.
	28	28.5	29	29.5	30	30.5	31	
°	+	+	+	+	+	+	+	°
0	.072	.073	.074	.076	.077	.078	.080	0
1	.069	.071	.072	.073	.074	.076	.077	1
2	.067	.068	.069	.070	.072	.073	.074	2
3	.064	.065	.067	.068	.069	.070	.071	3
4	.062	.063	.064	.065	.066	.067	.068	4
5	.059	.060	.061	.062	.063	.065	.066	5
6	.057	.058	.059	.060	.061	.062	.063	6
7	.054	.055	.056	.057	.058	.059	.060	7
8	.052	.053	.054	.054	.055	.056	.057	8
9	.049	.050	.051	.052	.053	.054	.054	9
10	.047	.047	.048	.049	.050	.051	.052	10
11	.044	.045	.046	.046	.047	.048	.049	11
12	.042	.042	.043	.044	.045	.045	.046	12
13	.039	.040	.040	.041	.042	.043	.043	13
14	.037	.037	.038	.038	.039	.040	.040	14
15	.034	.035	.035	.036	.036	.037	.038	15
16	.032	.032	.033	.033	.034	.034	.035	16
17	.029	.030	.030	.031	.031	.032	.032	17
18	.026	.027	.027	.028	.028	.029	.029	18
19	.024	.024	.025	.025	.026	.026	.027	19
20	.021	.022	.022	.023	.023	.023	.024	20
21	.019	.019	.020	.020	.020	.021	.021	21
22	.016	.017	.017	.017	.018	.018	.018	22
23	.014	.014	.014	.015	.015	.015	.015	23
24	.011	.012	.012	.012	.012	.012	.013	24
25	.009	.009	.009	.009	.009	.010	.010	25
26	.006	.006	.007	.007	.007	.007	.007	26
27	.604	.004	.004	.004	.004	.004	.004	27
28	.001	.001	.001	.001	.001	.001	.001	28
	—	—	—	—	—	—	—	
29	.001	.001	.001	.001	.001	.001	.001	29
30	.004	.064	.004	.004	.004	.004	.004	30
31	.006	.006	.007	.007	.007	.007	.007	31
32	.009	.009	.009	.009	.009	.010	.010	32
33	.011	.012	.012	.012	.012	.012	.012	33
34	.014	.014	.014	.015	.015	.015	.015	34
35	.016	.017	.017	.017	.018	.018	.018	35
36	.019	.019	.020	.020	.020	.021	.021	36
37	.021	.022	.022	.022	.023	.023	.024	37
38	.024	.024	.025	.025	.026	.026	.026	38
39	.026	.027	.027	.028	.028	.029	.029	39
40	.029	.029	.030	.030	.031	.031	.032	40
41	.031	.032	.033	.033	.034	.034	.035	41
42	.034	.034	.035	.036	.036	.037	.037	42
43	.036	.037	.038	.038	.039	.040	.040	43
44	.030	.040	.040	.041	.042	.042	.043	44
45	.041	.042	.043	.044	.044	.045	.046	45
46	.044	.045	.045	.046	.047	.048	.049	46
47	.046	.047	.048	.049	.050	.051	.051	47
48	.049	.050	.051	.052	.052	.053	.054	48
49	.051	.052	.053	.054	.055	.056	.057	49
50	.054	.055	.056	.057	.058	.059	.060	50

TABLE IX—Continued.

Temp. F.	Inches.							Temp. F.
	28	28.5	29	29.5	30	30.5	31	
°	—	—	—	—	—	—	—	°
51	.056	.057	.058	.059	.060	.061	.062	51
52	.059	.060	.061	.062	.063	.064	.065	52
53	.061	.063	.064	.065	.066	.067	.068	53
54	.064	.065	.066	.067	.068	.070	.071	54
55	.066	.068	.069	.070	.071	.072	.073	55
56	.069	.070	.071	.073	.074	.075	.076	56
57	.071	.073	.074	.075	.076	.078	.079	57
58	.074	.075	.077	.078	.079	.081	.082	58
59	.076	.078	.079	.080	.082	.083	.085	59
60	.079	.080	.082	.083	.085	.086	.087	60
61	.081	.083	.084	.086	.087	.089	.090	61
62	.084	.085	.087	.088	.090	.091	.093	62
63	.086	.088	.089	.091	.093	.094	.096	63
64	.089	.090	.092	.094	.095	.097	.098	64
65	.091	.093	.095	.096	.098	.100	.101	65
66	.094	.096	.097	.099	.101	.102	.104	66
67	.096	.098	.100	.102	.103	.105	.107	67
68	.099	.101	.102	.104	.106	.108	.109	68
69	.101	.103	.105	.107	.109	.110	.112	69
70	.104	.106	.108	.109	.111	.113	.115	70
71	.106	.108	.110	.112	.114	.116	.118	71
72	.109	.111	.113	.115	.117	.119	.120	72
73	.111	.113	.115	.117	.119	.121	.123	73
74	.114	.116	.118	.120	.122	.124	.126	74
75	.116	.118	.120	.122	.125	.127	.129	75
76	.119	.121	.123	.125	.127	.129	.131	76
77	.121	.123	.126	.128	.130	.132	.134	77
78	.124	.126	.128	.130	.133	.135	.137	78
79	.126	.128	.131	.133	.135	.127	.140	79
80	.129	.131	.133	.136	.138	.140	.143	80
81	.131	.134	.136	.138	.141	.143	.145	81
82	.134	.136	.138	.141	.143	.146	.148	82
83	.136	.139	.141	.143	.146	.148	.151	83
84	.139	.141	.144	.146	.149	.151	.154	84
85	.141	.144	.146	.149	.151	.154	.156	85
86	.144	.146	.149	.151	.154	.156	.159	86
87	.146	.149	.151	.154	.157	.159	.162	87
88	.149	.151	.154	.157	.159	.162	.165	88
89	.151	.154	.156	.159	.162	.165	.167	89
90	.153	.156	.159	.162	.164	.167	.170	90
91	.156	.159	.162	.165	.167	.170	.173	91
92	.158	.161	.164	.167	.170	.172	.175	92
93	.161	.164	.167	.170	.172	.175	.178	93
94	.163	.166	.169	.172	.175	.177	.180	94
95	.166	.169	.172	.175	.178	.180	.183	95
96	.168	.171	.174	.178	.181	.183	.186	96
97	.171	.174	.177	.180	.183	.186	.189	97
98	.173	.176	.179	.183	.186	.188	.191	98
99	.176	.179	.182	.185	.188	.191	.194	99
100	.178	.181	.184	.188	.191	.194	.197	100